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(54) **TORSIONAL VIBRATION DAMPER**

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Jul. 15, 2010	(DE)	10 2010 027 404
Jul. 22, 2010	(DE)	10 2010 031 989
Nov. 18, 2010	(DE)	10 2010 051 860

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CPC ***F16F 15/30*** (2013.01); ***F16F 15/123*** (2013.01); ***F16F 15/145*** (2013.01); *F16H 2045/0263* (2013.01); *Y10T 74/2128* (2013.01)

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CPC F16F 15/14; F16F 15/145; F16F 7/10; F16F 15/30; F16F 15/123; F16H 2045/0263; Y10T 74/2128
USPC .... 74/574.2, 572.2, 572.21; 192/30 V, 205; 464/180; 188/378; 123/192.1–192.2
See application file for complete search history.

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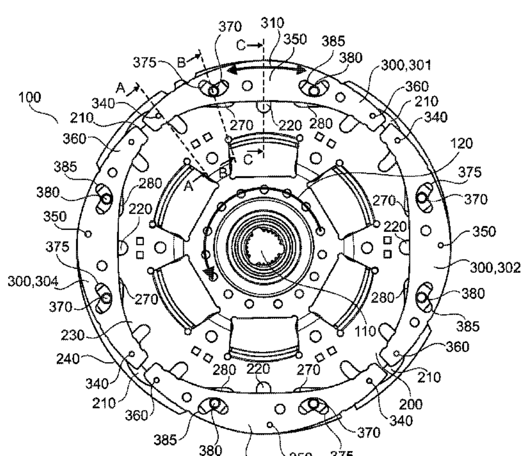
(57) **ABSTRACT**

A torsional vibration damper for a drivetrain of a motor vehicle having a substantially discoidal centrifugal flange and a plurality of centrifugal pendulum-type absorbers. Each centrifugal pendulum-type absorber includes a first pendulum mass and a second pendulum mass. The first pendulum mass is arranged above a first surface of the pendulum flange, and the second pendulum mass is arranged above a second surface of the pendulum flange. The first pendulum mass and the second pendulum mass are firmly connected to each other by means of at least two spacing bolts in each case. The pendulum flange has a plurality of cutouts in which the spacing bolts are guided. A second spacing bolt of a first centrifugal pendulum-type absorber and a first spacing bolt of a second centrifugal pendulum-type absorber are guided in at least one first cutout.

4 Claims, 8 Drawing Sheets



(51) **Int. Cl.**

F16F 15/14	(2006.01)
F16H 45/02	(2006.01)

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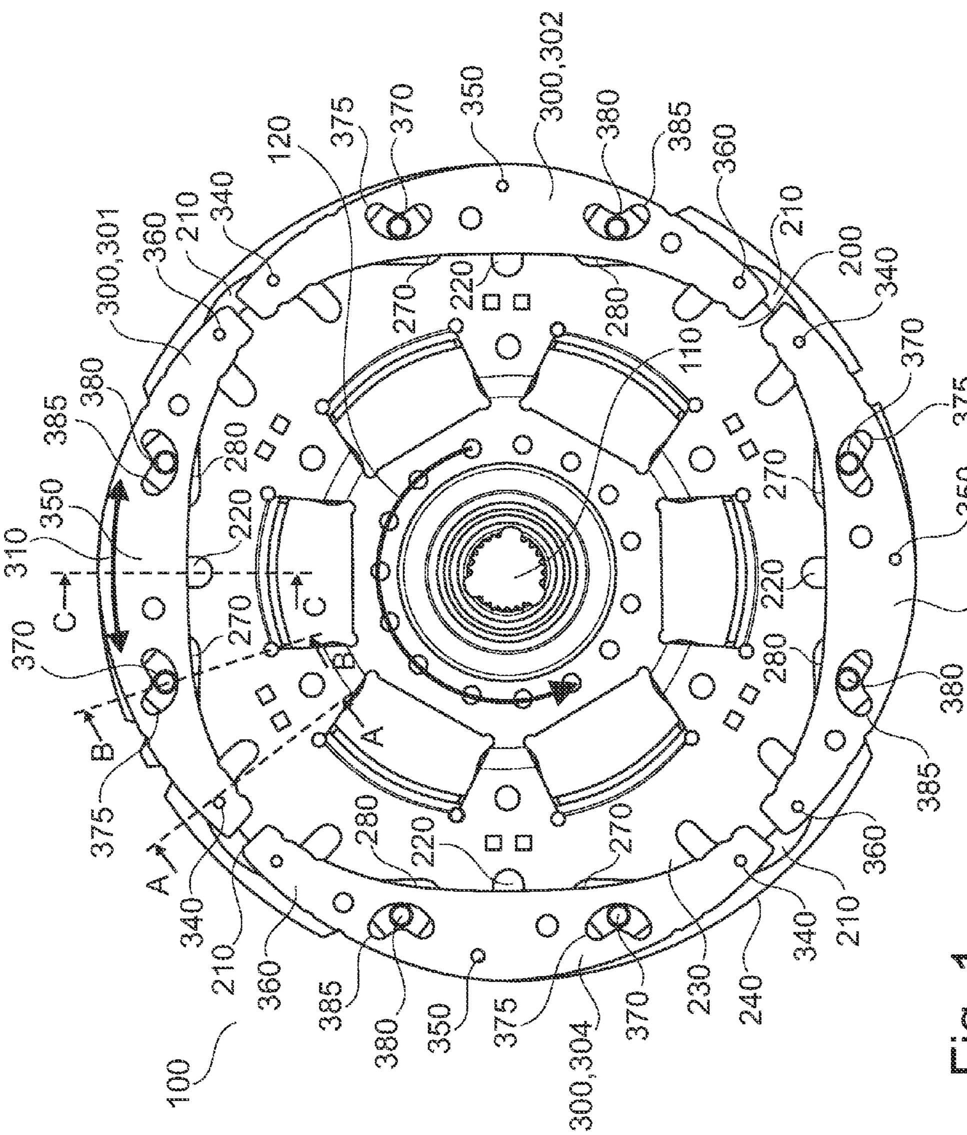
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375
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A
B
C

Fig. 1

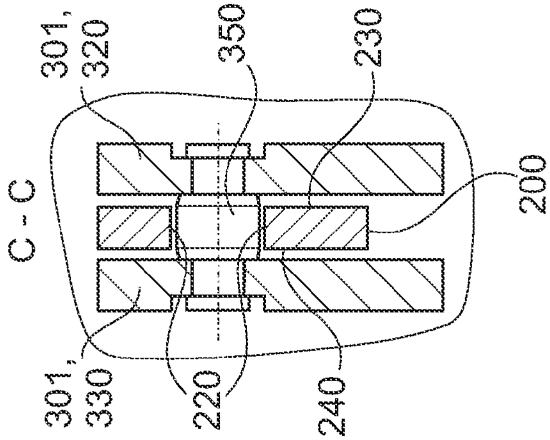


Fig. 4

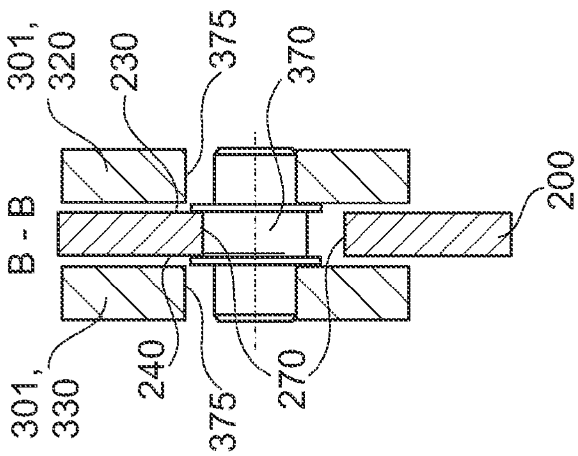


Fig. 3

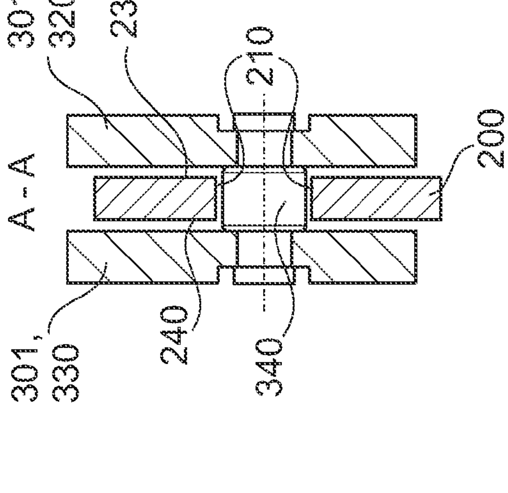


Fig. 2

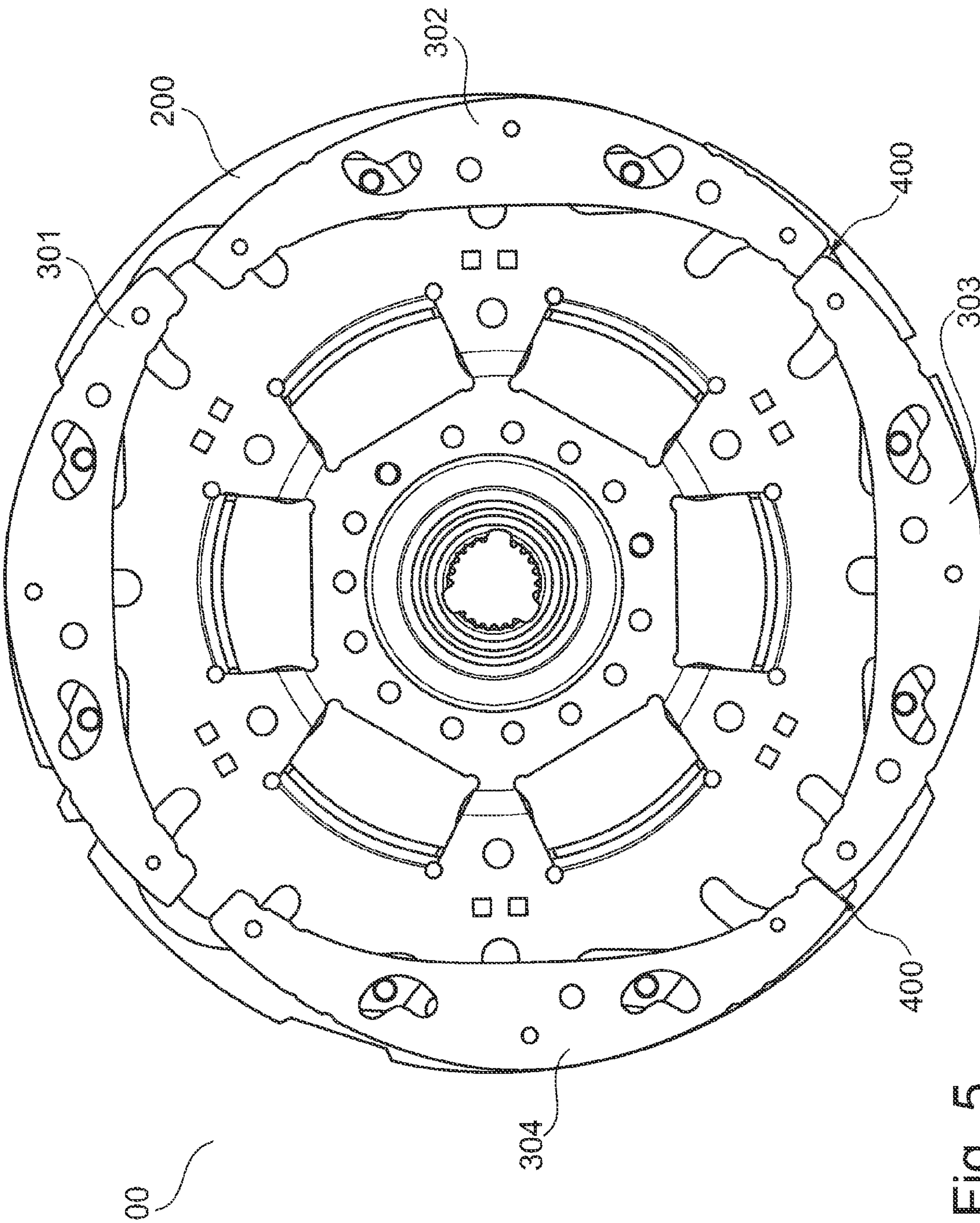
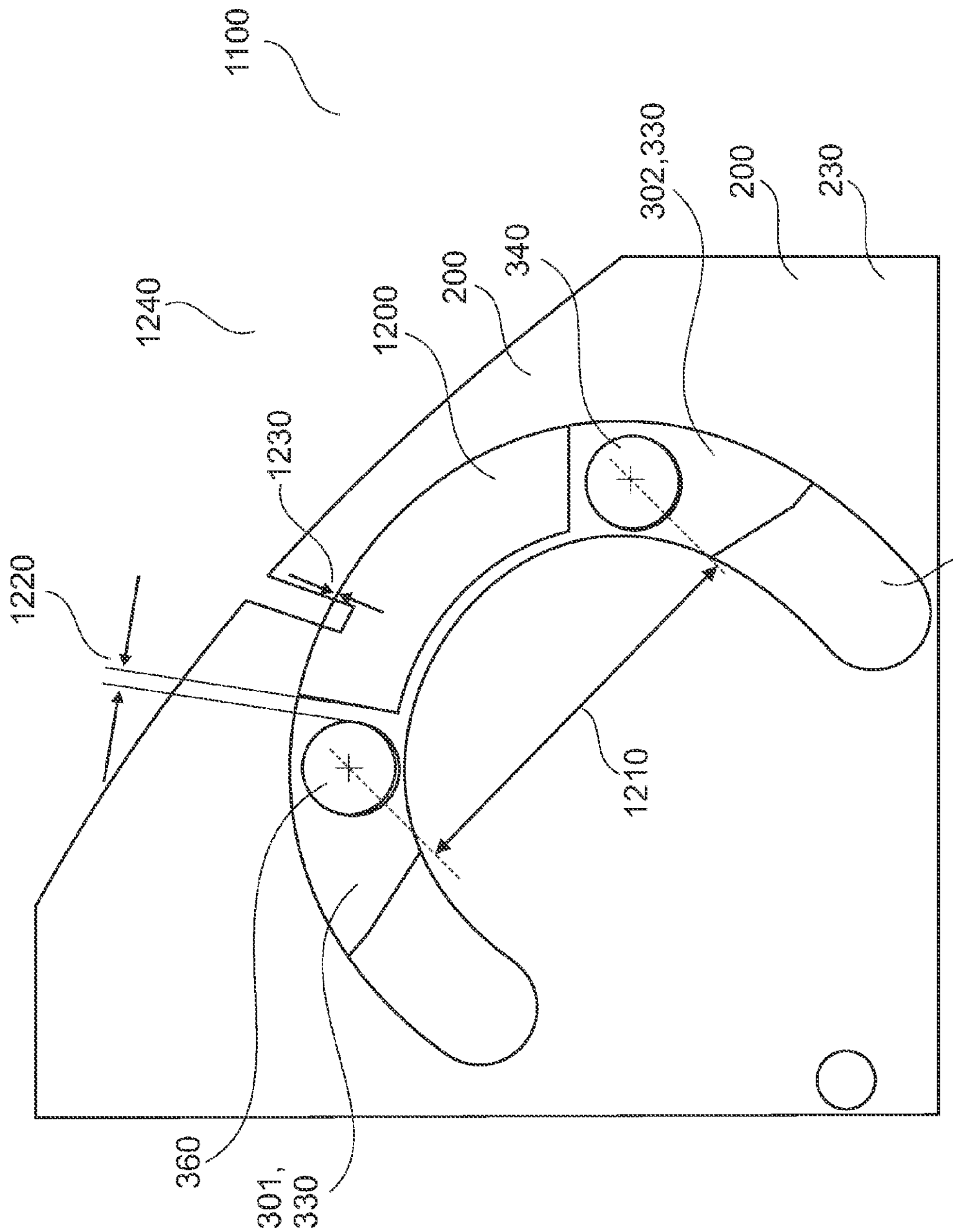


Fig. 5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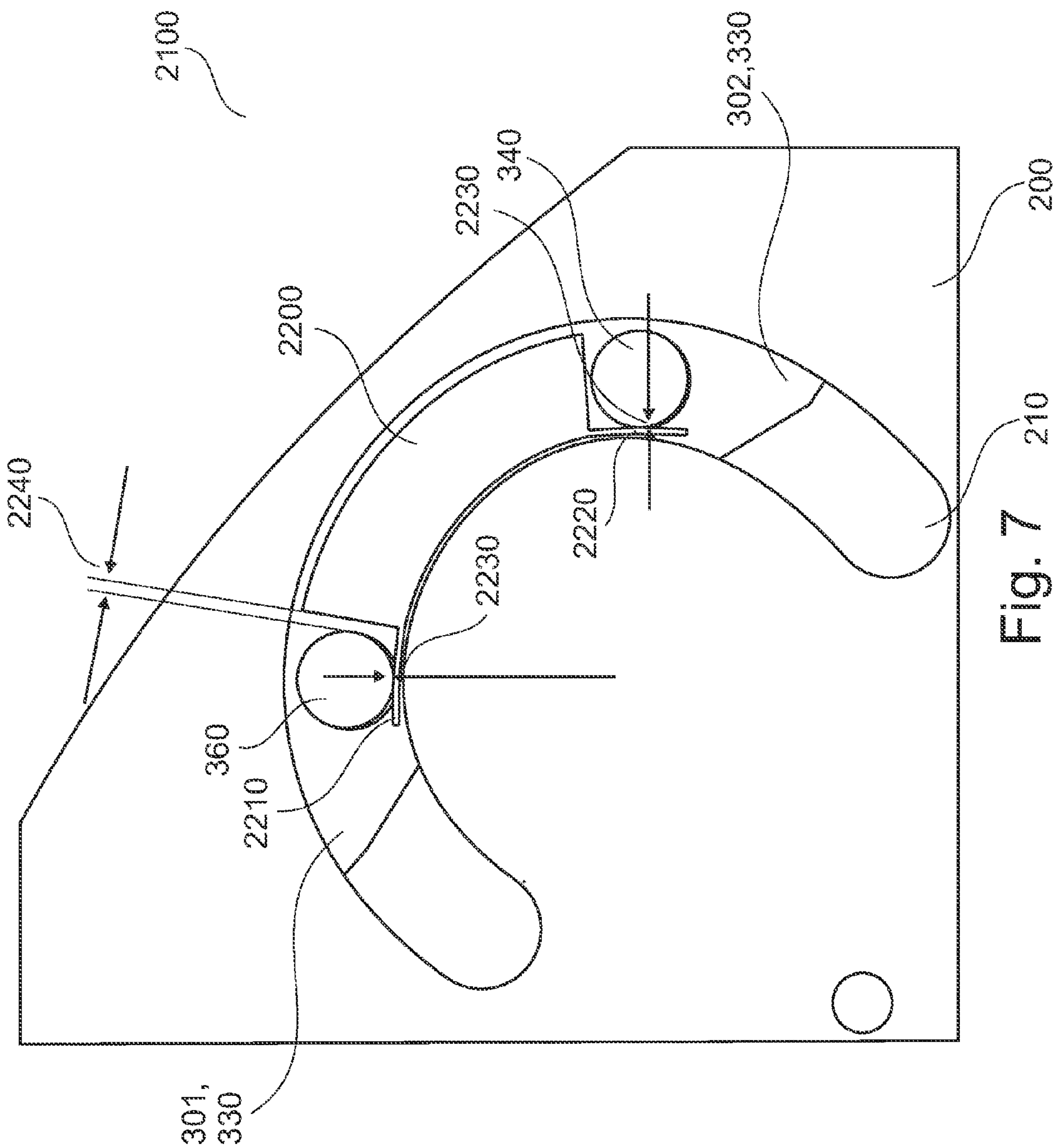
301,
330

Fig. 6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301,
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Fig. 7

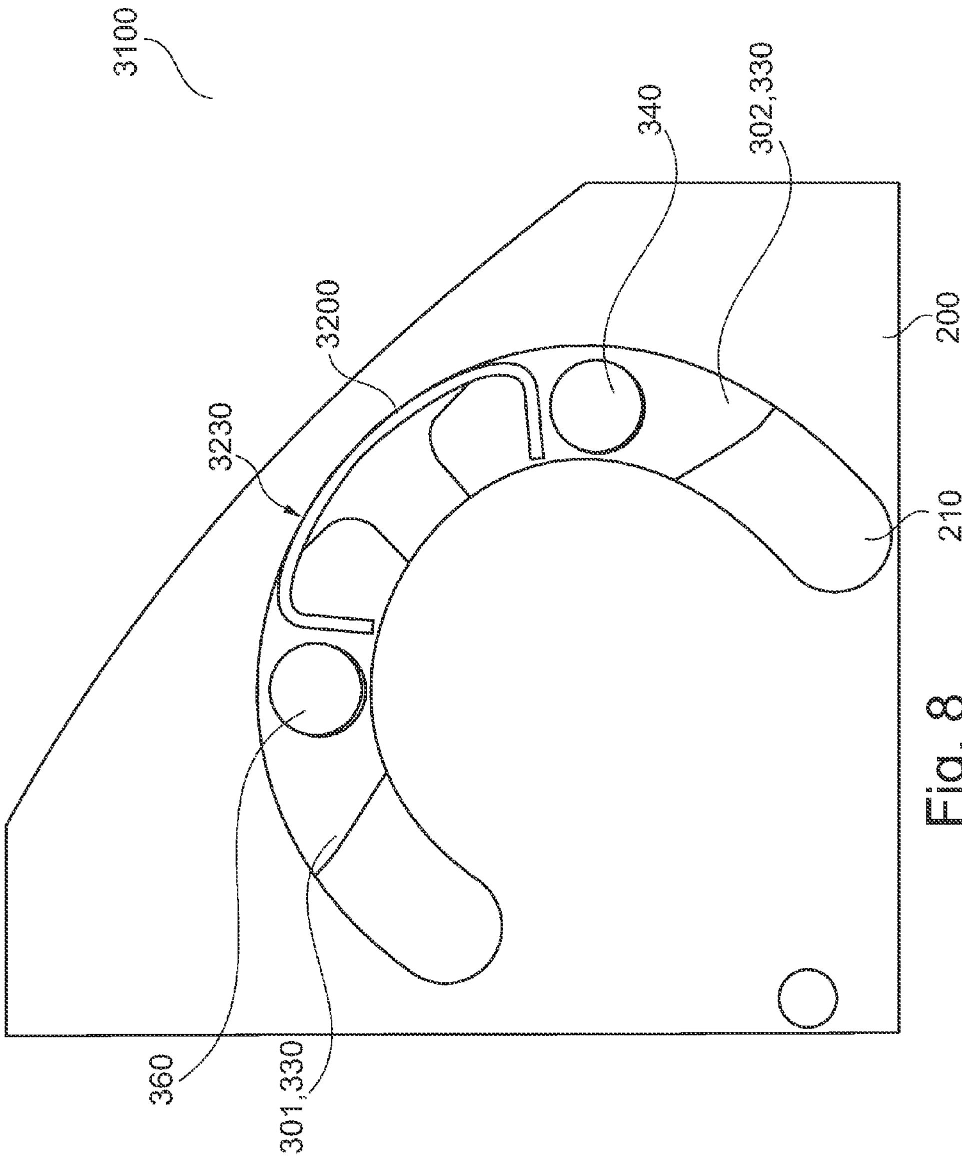

Fig. 8

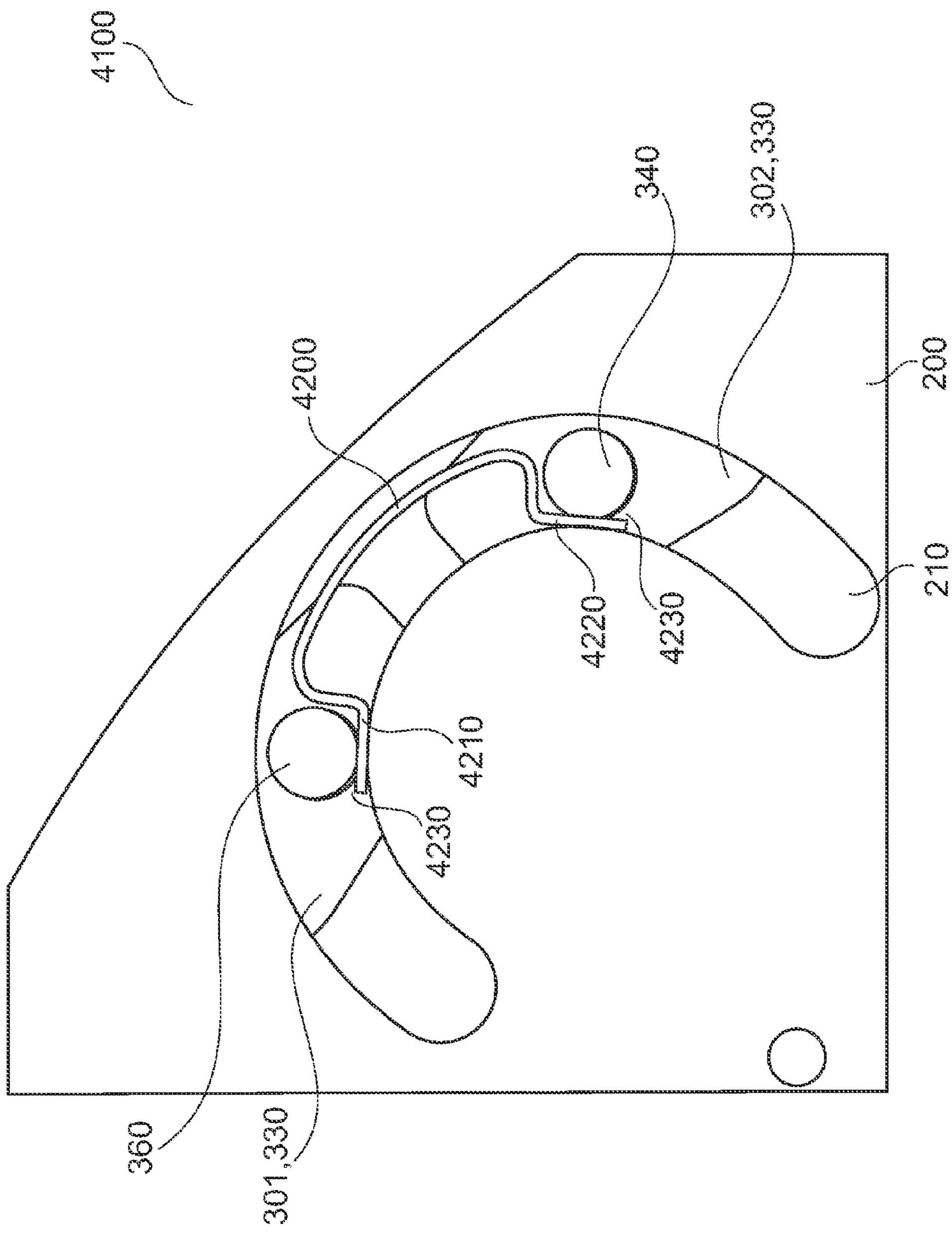

Fig. 9

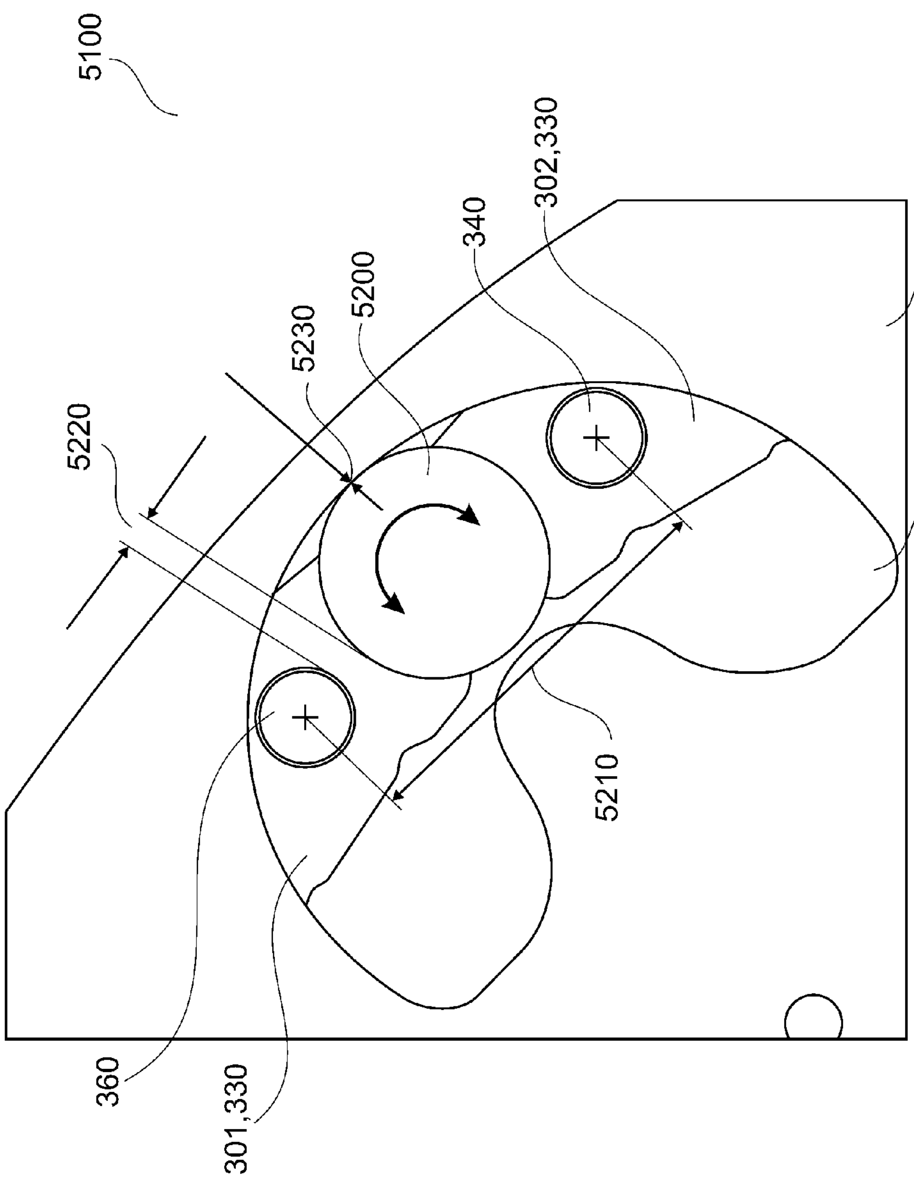

Fig. 10

TORSIONAL VIBRATION DAMPER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is filed under 35 U.S.C. §120 and §365(c) as a continuation of International Patent Application PCT/DE2011/000197, filed Feb. 28, 2011, which application claims priority from German Patent Application No. 10 2010 011 142.2, filed Mar. 11, 2010, German Patent Application No. 10 2010 027 404.6, filed Jul. 15, 2010, German Patent Application No. 10 2010 031 989.9, filed Jul. 22, 2010, and German Patent Application No. 10 2010 051 860.3, filed Nov. 18, 2010, which applications are incorporated herein by reference in their entireties.

FIELD OF THE INVENTION

The present invention relates to a torsional vibration damper.

BACKGROUND OF THE INVENTION

Torsional vibration can arise in a drivetrain of a motor vehicle. To suppress this torsional vibration, it is known to use torsional vibration dampers arranged in the drivetrain. Such torsional vibration dampers or rotational vibration dampers consist of a substantially discoidal pendulum flange on which a plurality of centrifugal pendulum-type absorbers in the form of mass elements are attached. The centrifugal pendulum-type absorbers can move in the radial direction and peripheral direction of the pendulum flange.

The pendulum flange is made to rotate by the drivetrain. The centrifugal pendulum-type absorbers are pushed radially outward, and the amount of outward-directed centrifugal force depends on the speed of the drivetrain. An uneven angular velocity of the drivetrain that, for example, is generated by the operating cycles of an internal combustion engine, causes deflections of the centrifugal pendulum-type absorbers in the circumferential direction of the pendulum flange, which attenuate the unevenness of the angular velocity of the drivetrain. Such a torsional vibration damper is, for example, known from German Patent Application No. 10 2009 042 831 A1.

When the speed and angular velocity of the drivetrain are low, the centrifugal force acting on the centrifugal pendulum-type absorbers can, in certain circumstances, be insufficient to keep the centrifugal pendulum-type absorbers in their positions radially to the outside. Under the influence of gravity, the centrifugal pendulum-type absorbers can instead shift so that neighboring centrifugal pendulum-type absorbers bump against each other. This generates noise that is perceived as annoying and problematic.

BRIEF SUMMARY OF THE INVENTION

The object of the present invention is therefore to provide an improved torsional vibration damper.

The present invention is a torsional vibration damper for a drivetrain of a motor vehicle, including a substantially discoidal centrifugal flange and a plurality of centrifugal pendulum-type absorbers. Each centrifugal pendulum-type absorber has a first pendulum mass and a second pendulum mass. The first pendulum mass is arranged above a first surface of the pendulum flange, and the second pendulum mass is arranged above a second surface of the pendulum flange. In addition, the first pendulum mass and the second pendulum

mass of each centrifugal pendulum-type absorber are firmly connected to each other by means of at least two spacing bolts in each case. The pendulum flange has a plurality of cutouts in which the spacing bolts are guided, where a second spacing bolt of a first centrifugal pendulum-type absorber and a first spacing bolt of a second centrifugal pendulum-type absorber are guided in at least one first cutout. In addition, a spacing element is arranged in the first cutout that is dimensioned such that the first centrifugal pendulum-type absorber and second centrifugal pendulum-type absorber cannot contact each other. The spacing element then prevents the first centrifugal pendulum-type absorber and the second centrifugal pendulum-type absorber from impacting each other. This prevents the annoying development of noise even at low drivetrain speeds.

The spacing element is preferably arranged floating in the first cutout. The spacing element can then preferably follow the deflection of the centrifugal pendulum-type absorber.

It is also preferable for the spacing element to be flat and have basically the same thickness as the pendulum flange. The spacing element can then be preferably arranged in the first cutout and does not cause any additional friction between the spacing element and the pendulum masses of the centrifugal pendulum-type absorber.

In one embodiment, the first cut out basically has the shape of an annular sector, and the spacing element also basically has the shape of an annular sector. This is a particularly simple design of the spacing element.

In another embodiment, the spacing element has the shape of a bracket. This spacing element has particularly low mass.

It is particularly preferable for the spacing element to have the shape of a bracket open toward the midpoint of the pendulum flange. The spacing element can then preferably easily slide off a radially outer boundary edge of the first cutout.

In a further development of the invention, the spacing element has a first wing that is arranged between the second spacing bolt of the first centrifugal pendulum-type absorber and an edge of the first cutout, and also a second wing that is arranged between the first spacing bolt of the second centrifugal pendulum-type absorber and an edge of the first cutout. Preferably, in this development, no friction arises between the spacing element and the pendulum flange. In addition, only a slight amount of friction arises between the spacing element and the spacing bolt.

In another embodiment, the spacing element is designed in the shape of a circular disc. Preferably, the discoidal spacing element can then roll in the first cutout. Consequently, instead of gliding friction, only rolling friction arises in this embodiment and this is reduced compared with the gliding friction.

It is also preferable for the spacing element to not completely fill the gap between the second spacing bolt of the first centrifugal pendulum-type absorber and the first spacing bolt of the second centrifugal pendulum-type absorber when the first centrifugal pendulum-type absorber and the second centrifugal pendulum-type absorber are in a resting position. This allows a certain asynchrony between the deflections of the plurality of centrifugal pendulum-type absorbers in a peripheral direction. The circumferential pendulum-type absorbers can then move independently from each other and are not coupled, which improves the damping properties of the torsional vibration damper. In addition, the spacing bolts and the spacing element in this embodiment do not contact each other at high speeds and low torsional vibrations; consequently, no friction arises between the spacing bolts and the spacing element. In addition, friction does not arise between the spacing element and the pendulum flange in this operating state since the spacing element it is not moved in the cutout.

The torsional vibration damper can be designed as a dual-mass flywheel or as a single-stage or multistage torsional vibration damper. The torsional vibration damper can also be arranged in conjunction with a hydrodynamic torque converter or a clutch device.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The nature and mode of operation of the present invention will now be more fully described in the following detailed description of the invention taken with the accompanying drawing figures, in which:

FIG. **1** is a plan view of a known torsional vibration damper;

FIGS. **2** to **4** are sections of the torsional vibration damper of FIG. **1**;

FIG. **5** is another view of the torsional vibration damper;

FIG. **6** shows a first embodiment of a torsional vibration damper;

FIG. **7** illustrates a second embodiment of a torsional vibration damper;

FIG. **8** depicts a third embodiment of a torsional vibration damper;

FIG. **9** shows a fourth embodiment of a torsional vibration damper; and,

FIG. **10** illustrates a fifth embodiment of a torsional vibration damper.

DETAILED DESCRIPTION OF THE INVENTION

At the outset, it should be appreciated that like drawing numbers on different drawing views identify identical, or functionally similar, structural elements of the invention. While the present invention is described with respect to what is presently considered to be the preferred aspects, it is to be understood that the invention as claimed is not limited to the disclosed aspects.

Furthermore, it is understood that this invention is not limited to the particular methodology, materials and modifications described and, as such, may, of course, vary. It is also understood that the terminology used herein is for the purpose of describing particular aspects only, and is not intended to limit the scope of the present invention, which is limited only by the appended claims.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs. Although any methods, devices or materials similar or equivalent to those described herein can be used in the practice or testing of the invention, the preferred methods, devices, and materials are now described.

FIG. **1** shows a plan view of known torsional vibration damper **100**. Torsional vibration damper **100** generally includes discoidal first pendulum flange **200** with centrally arranged hub **110**. Pendulum flange **200** can be made to rotate via hub **110** by means of a drivetrain of a motor vehicle. Rotational direction **120** indicated in FIG. **1** corresponds to a line of sight from a transmission arranged in a drivetrain of the motor vehicle toward the internal combustion engine of the motor vehicle.

Torsional vibration damper **100** serves to dampen the torsional vibrations of the drivetrain. To this end, torsional vibration damper **100** has plurality of centrifugal pendulum-type absorbers **300**. In the embodiment shown in FIG. **1**, there are four centrifugal pendulum-type absorbers **300**, that is, first centrifugal pendulum-type absorber **301**, second centrifugal pendulum-type absorber, third centrifugal pendulum-type absorber **303**, and fourth centrifugal pendulum-type absorber **304**. However, a different number of centrifugal pendulum-type absorbers **300** can also be provided. The centrifugal pendulum-type absorbers are designed identically.

FIGS. **2** to **4** show different sections of first centrifugal pendulum-type absorber **301** and first pendulum flange **200**. It can be seen in FIGS. **2** to **4** that each of centrifugal pendulum-type absorbers **300** includes first pendulum mass **320** and second pendulum mass **330**. First pendulum mass **320** of each centrifugal pendulum-type absorber **300** is arranged above first surface **230** of pendulum flange **200** visible in FIG. **1**. Second pendulum mass **330** of each centrifugal pendulum-type absorber **300** is arranged above rear second surface **240** of pendulum flange **200** which cannot be seen in FIG. **1**.

Pendulum flange **200** of torsional vibration damper **100** has plurality of U-shaped cutouts **210**, where the number of U-shaped cutouts **210** corresponds to the number of centrifugal pendulum-type absorbers **300**. In the embodiment shown in FIG. **1**, there are accordingly four U-shaped cutouts **210**. Each U-shaped cutout **210** forms a penetration through pendulum flange **200** and is arranged so that the open side of U-shaped cutout **200** faces toward hub **110** of pendulum flange **200**, whereas the closed side of U-shaped cutout **210** is oriented radially outward.

In addition, pendulum flange **200** has plurality of central cutouts **220**, the number of which corresponds to the number of centrifugal pendulum-type absorbers **300**. The middle cutouts are also designed as complete penetrations through pendulum flange **200**. Each middle cutout **220** is arranged in a circumferential direction of pendulum flange **200** between two U-shaped cutouts **210**.

In addition, pendulum flange **200** has plurality of first roller cutouts **270**. The number of first roller cutouts **270** also corresponds to the number of centrifugal pendulum-type dampers **300**. First roller cutouts **270** are also complete penetrations through pendulum flange **200**. Each first roller cutout **270** is arranged in a circumferential direction of pendulum flange **200** between middle cutout **220** and U-shaped cutout **210**.

In addition, first pendulum flange **200** has two roller cutouts **280**, the number of which corresponds to the number of centrifugal pendulum-type absorbers **300**. Second roller cutouts **280** are formed to symmetrically mirror first roller cutouts **270**. Each second roller cutout **280** is arranged in a circumferential direction of pendulum flange **200** between middle cutout **220** and U-shaped cutout **210**. Consequently, U-shaped cutout **210**, first roller cutout **270**, middle cutout **220**, second roller cutout **280** and another U-shaped cutout **210** follow each other in a circumferential, clockwise direction of pendulum flange **200**.

First pendulum mass **320** and second pendulum mass **330** of each circumferential pendulum-type absorber **300** are designed identically. Each pendulum mass **320**, **330** is designed approximately in the shape of a crescent or ring sector. The angle covering the annular sector is somewhat less than 360° divided by the number of centrifugal pendulum-type absorbers **300**. In the example in FIG. **1**, the angle covering pendulum masses **320**, **330** is, for example, somewhat less than 90°. This makes it possible to arrange individual centrifugal pendulum-type absorbers **300** at a distance from each other on the circumference of pendulum flange **200**.

Each pendulum mass **320**, **330** has third roller cutout **375** and fourth roller cutout **385**. Third and fourth roller cutouts **375**, **385** are designed as penetrations through respective pendulum mass **320**, **330** and are arranged symmetrically with reference to an axis of symmetry of annular-sector-shaped pendulum masses **320**, **330**.

FIG. **2** shows a section of a part of torsional vibration damper **100** along the straight line AA shown in FIG. **1**. It can be seen that first pendulum mass **320** and second pendulum mass **330** of first centrifugal pendulum-type absorber **301** are connected with each other firmly and at a distance by first spacing bolt **340**. First spacing bolt **340** is guided through one of U-shaped cutouts **210** of pendulum flange **200**. FIG. **4** shows a section through a part of torsional vibration damper **100** along the straight line CC shown in FIG. **1**. In FIG. **4**, it can be seen that first pendulum mass **320** and second pendulum mass **330** of first centrifugal pendulum-type absorber **301** are also firmly connected to each other by second spacing bolt **350** and run through one of middle cutouts **220** in pendulum flange **200**. It can also be seen in FIG. **1** that there is third spacing bolt **360** which is symmetrically mirrored with reference to the axis of symmetry of first centrifugal pendulum-type absorber **301** and firmly connects first pendulum mass **320** and second pendulum mass **330** of first centrifugal pendulum-type absorber **301** and runs through another U-shaped cutout **210** in pendulum flange **200**. In FIG. **1**, it can also be seen that first spacing bolt **340** of first centrifugal pendulum-type absorber **301** and third spacing bolt **360** of neighboring second centrifugal pendulum-type absorber **302** are arranged in each of the U-shaped cutouts **210**.

FIG. **3** shows a section of a part of torsional vibration damper **100** along the straight line BB shown in FIG. **1**. It can be seen in FIG. **3** that first roller **370** is arranged in third roller cutout **375** of first centrifugal pendulum-type absorber **301** and one of first roller cutouts **270** of pendulum flange **200**. The movement of first centrifugal pendulum-type absorber **301** relative to first pendulum flange **200** is limited in radial direction by first roller **270**. It can also be seen in FIG. **1** that second roller **380** with a design corresponding to that of first roller **370** is arranged in fourth roller cutout **385** of first centrifugal pendulum-type absorber **301** and second roller cutout **280** of pendulum flange **200**.

If torsional vibration damper **100** is made to rotate by the drivetrain of the motor vehicle about a rotary axis formed by hub **110**, centrifugal force directed radially outward acts on centrifugal pendulum-type absorber **300** which deflects centrifugal pendulum-type absorber **300** in a radial direction until pendulum masses **320**, **330** of each centrifugal pendulum-type absorber **300** contact rollers **370**, **380** as shown in FIG. **3**. Torsional vibration which overlaps the rotation causes centrifugal pendulum-type absorber **300** to experience deflections in the circumferential direction of pendulum flange **200**. Rollers **370**, **380** are thereby made to rotate and roll along the edges of cutouts **375**, **385** of circumferential pendulum-type absorber **300** and the edges of cutouts **270**, **280** of pendulum flange **200**. The rotary motion of the overlapping torsional vibrations is dampened by this deflectability of centrifugal pendulum-type absorber **300** in the circumferential direction of pendulum flange **200**. The vibrations of centrifugal pendulum-type absorbers **300** are substantially synchronized, although a certain amount of asynchrony is possible.

If the speed of the drivetrain falls below a certain minimum level which can, for example, lie around 300 rpm, the centrifugal force acting on centrifugal pendulum-type absorber **300** is no longer sufficient to completely deflect centrifugal pendulum-type absorber **300** in a radial direction. Under the influence of gravity, individual centrifugal pendulum-type absorbers **300** can collide. This is, for example, illustrated in FIG. **5** where second centrifugal pendulum-type absorber **302**, third centrifugal pendulum-type absorber **303** as well as fourth centrifugal pendulum-type absorber **304** impact each other at two collision points **400**. The impact of centrifugal pendulum-type absorbers **300** generates noise that is perceived as annoying.

FIG. **6** shows a section of a first embodiment of first torsional vibration damper **1100**. FIG. **6** shows a section of first pendulum flange **200** with one of U-shaped cutouts **210**, a section of second pendulum mass **330** of first centrifugal pendulum-type absorber **301** lying behind pendulum flange **200**, a section of second pendulum mass **330** of second centrifugal pendulum-type absorber **302** lying behind pendulum flange **200**, as well as third spacing bolt **360** of first centrifugal pendulum-type absorber **301**, and first of spacing bolt **340** of second centrifugal pendulum-type absorber **302**. In addition, first spacing element **1200** is arranged in U-shaped cutout **210**. Like U-shaped cutout **210**, first spacing element **1200** is designed approximately in the shape of an annual sector, although covering a smaller angle than U-shaped cutout **210**. In a radial direction as well as in the direction between the inner and outer ring neighboring first spacing element **1200**, first spacing element **1200** has a width that is slightly less than U-shaped cutout **210**. In the direction perpendicular to first surface **230** of pendulum flange **200**, the thickness of first spacing element **1200** is approximately the same as that of pendulum flange **200**.

First spacing element **1200** is arranged between third spacing bolt **360** of first centrifugal pendulum-type absorber **301** and first spacing bolt **340** of second centrifugal pendulum-type absorber **302**. The dimension of the angle covered by first spacing element **1200** is such that inner distance **1220** is formed between third spacing bolt **360** of first centrifugal pendulum-type absorber **301** and first spacing element **1200**, as well as between first spacing bolt **340** of second centrifugal pendulum-type absorber **302** and first spacing element **1200** by which spacing bolts **340**, **360** and first spacing element **1200** are spaced from each other when centrifugal pendulum-type absorbers **301**, **302** are in their resting position. If first centrifugal pendulum-type absorber **301** and second centrifugal pendulum-type absorber **302** approach each other due to the asynchronous deflection of centrifugal pendulum-type absorbers **301**, **302** in a circumferential direction of pendulum flange **200**, they can only approach until spacing bolts **340**, **360** come into contact with first spacing element **1200**. Consequently, first spacing element **1200** always ensures minimum pendulum distance **1210** between third spacing bolt **360** of the first centrifugal pendulum-type absorber **301** and first spacing bolt **340** of second centrifugal pendulum-type absorber **302**.

If first torsional vibration damper **1100** is rotating, centrifugal force **1240** acting on first spacing element **1200** causes first spacing element **1200** to contact the radially outer edge of U-shaped cutout **210**. If first centrifugal pendulum-type absorber **301** and second centrifugal pendulum-type absorber **302** are deflected in the circumferential direction of pendulum flange **200**, this also causes first spacing element **1200** to shift within U-shaped cutout **210** in the circumferential direction of pendulum flange **200**. This causes friction to arise in friction area **1230** on the radially outer edge of U-shaped cutout **210**. This friction increases with the speed of first torsional vibration damper **1100**. Investigations have, however, shown that this friction does not negatively influence the functioning and transmissibility of first torsional vibration damper **1100**.

Different inner distance **1220** can be chosen depending on requirements. If chosen inner distance **1220** is relatively large, the deflections of centrifugal pendulum-type absorber **300** in centrifugal-type pendulum flange **200** can be asynchronous. Centrifugal pendulum-type absorbers **300** then move independently of each other and are not coupled. At high speeds of first torsional vibration damper **1100** and at low torsional vibrations, spacing bolts **340**, **360** and first spacing element **1200** do not contact each other; consequently, no friction can arise in this area either. Likewise, no friction arises between spacing element **1200** and the edges of U-shaped cutout **210** in this operating mode since first spacing element **1200** remains immovable in U-shaped cutout **210**. However, chosen inner distance **1220** can be small enough to render asynchronous, lateral deflections of centrifugal pendulum-type absorber **300** impossible, and individual centrifugal pendulum-type absorbers **300** are coupled and deflected synchronously in the circumferential direction of pendulum flange **200**.

FIG. **7** shows a section of an embodiment of a second torsional vibration damper **2100**. The portrayed section corresponds to that of first torsional vibration damper **1100** of FIG. **6**. However, second spacing element **2200** is provided in U-shaped cutout **210** in second torsional vibration damper **2100** instead of first spacing element **1200**. In contrast to the first of spacing element **1200**, second spacing element **2200** has first wing **2210** and second wing **2220**. First wing **2210** extends as a projection of the outer edge radially to the inside of second spacing element **2200** between third spacing bolt **360** of first centrifugal pendulum-type absorber **301** and the radially inner edge of U-shaped cutout **210**. Second wing **2220** extends as the outer edge radially to the inside of second spacing element **2200** in the area between third spacing bolt **340** of second centrifugal pendulum-type absorber **302** and the radially inner edge of U-shaped cutout **210**. Wings **2210**, **2220** are therefore substantially perpendicular to the radial marginal surfaces of second spacing element **2200**. Wings **2210**, **2220** of second spacing element **2200** prevent second spacing element **2200** from being deflected against the radial outer edge of U-shaped cutout **210** even under the influence of centrifugal force acting on second spacing element **2200**. Instead, wings **2210**, **2220** contact spacing bolts **340**, **360** under the influence of centrifugal force acting radially to the outside. Consequently, friction is also prevented from arising between second spacing element **2200** and first pendulum flange **200**. A slight amount of friction only arises in friction area **2230** between wings **2210**, **2220** and spacing bolts **340**, **360**. With reference to chosen inner distance **2240** between the section of spacing element **2200** in the shape of the annular sector and spacing bolts **340**, **360** the aforementioned relating to spacing element **1200** in FIG. **6** apply.

FIG. **8** shows a section of an embodiment of a third torsional vibration damper **3100**. Instead of first spacing element **1200** of first torsional vibration damper **1100** in FIG. **6**, third torsional vibration damper **3100** has third spacing element **3200**. The outer contour of third spacing element **3200** is also in the shape of an annular sector and corresponds to that of first spacing element **1200**. However, in comparison to first spacing element **1200**, the radially inner marginal edge and the majority of the surface area of third spacing element **3200** have been removed so that only the radially outer marginal edge and the two radial marginal edges remain. Overall, third spacing element **3200** has the shape of a bracket with an open side facing toward the center of pendulum flange **200**. In comparison to first spacing element **1200**, third spacing element **3200** has less mass. In addition, the bracket-like shape of third spacing element **3200** lends elasticity to third spacing element **3200**. This elasticity can dampen the impact of spacing bolts **340**, **360** with third spacing element **3200**, thereby additionally reducing noise. As is the case with first spacing element **1200**, friction can arise in radially outer friction area **3230** between third spacing element **3200** and the radially outer edge of U-shaped cutout **210** which, however, has not proven to be problematic.

FIG. **9** shows a section of an embodiment of a fourth torsional vibration damper **4100**. Instead of first spacing element **1200** of the first torsional vibration damper, the fourth torsional vibration damper has fourth spacing element **4200** arranged in U-shaped cutout **210**. Fourth spacing element **4200** is the same as third spacing element **3200** of third torsional vibration damper **3100**, however in contrast to thereto, it has third wing **4210** and fourth wing **4220** like second spacing element **2200** of second torsional vibration damper **2100**. Third wing **4210** extends from one of the radial side edges of fourth spacing element **4200** in an area of U-shaped cutout **210** lying between third spacing bolt **360** of first centrifugal pendulum-type absorber **301** and the radially inner edge of U-shaped cutout **210**. Fourth leg **4220** correspondingly extends from the opposite radial outer edge of fourth spacing element **4200** in an area of U-shaped cutout **210** that lies between the radially inner marginal edge of U-shaped cutout **210** and first spacing bolt **340** of second centrifugal pendulum-type absorber **302**. Overall, fourth spacing element **4200** consequently has a shape reminiscent of the Greek capital letter omega. As is the case with second spacing element **2200** of second torsional vibration damper **2100**, wings **4210**, **4220** of fourth spacing element **4200** prevent fourth spacing element **4200** from contacting the radially outer edge of U-shaped cutout **210** even under the influence of centrifugal force acting radially to the outside; consequently, no friction can arise there either. Instead, there is slight friction only in friction areas **4230** between wings **4210**, **4220** and spacing bolts **340**, **360**.

FIG. **10** shows a section of an embodiment of a fifth torsional vibration damper. Instead of first pendulum flange **200**, fifth torsional vibration damper **5100** has second pendulum flange **5300** that has wider U-shaped cutout **5310** instead of U-shaped cutout **210**. In comparison to U-shaped cutout **210**, wider U-shaped cutout **5100** is designed wider so that the difference between the outer radius and inner radius of the cutout is greater. Third spacing bolt **360** of first centrifugal pendulum-type absorber **301** and first spacing bolt **340** of second centrifugal pendulum-type absorber **302** are guided in wider U-shaped cutout **5310**. In addition, fifth spacing element is arranged **5200** in wider cutout **5310** between spacing bolts **340**, **360** and is designed as a circular disc in this embodiment. The diameter of the circular disc is slightly less than the difference between the outer diameter and the inner diameter of cutout **5310**. Fifth spacing element **5200** prevents first centrifugal pendulum-type absorber **301** from impacting second centrifugal pendulum-type absorber **302** since spacing bolts **340**, **360** contact fifth spacing element **5200** before centrifugal pendulum-type absorbers **5200** contact. If centrifugal pendulum-type absorbers **301**, **302** are in a resting position, inner distance **5220** arises between fifth spacing element **5200** and spacing bolts **340**, **360** which prevents centrifugal pendulum-type absorbers **301**, **302** from contacting. The diameter of fifth spacing element **5200** in the shape of an annular segment and inner distances **5220** can be chosen to ensure that third spacing bolt **360** of first centrifugal pendulum-type absorber **301** and first spacing bolt **340** of second centrifugal pendulum-type absorber **302** always maintain minimum pendulum distance **5210**. The advantage of designing fifth spacing element **5200** as a circular disc is that fifth spacing element **5200** can roll on the edges of wider U-shaped cutout **5110**. Consequently, instead of sliding friction, reduced rolling friction can arise between fifth spacing element **5200** and the edges at second pendulum flange **5300** bordering wider U-shaped cutout **5310**.

Instead of the embodiments of spacing elements **1200**, **2200**, **3200**, **4200**, **5200** shown in FIGS. **6** to **10**, a spacing element can be used with a different shape.

Instead of the spacing elements, shortening pendulum masses **320**, **330** of centrifugal pendulum-type absorber **300** can prevent centrifugal pendulum-type absorber **300** from being hit. This would however also reduce the mass of centrifugal pendulum-type absorber **300** which would reduce the damping properties of the torsional vibration damper. In addition, spacing bolts **340**, **360** of centrifugal pendulum-type absorber **300** would then hit pendulum flange **200**, **5300**.

The invention can be used for all torsional vibration dampers in which the outer spacing bolts of two centrifugal pendulum-type absorbers are guided in a common cutout.

Thus, it is seen that the objects of the present invention are efficiently obtained, although modifications and changes to the invention should be readily apparent to those having ordinary skill in the art, which modifications are intended to be within the spirit and scope of the invention as claimed. It also is understood that the foregoing description is illustrative of the present invention and should not be considered as limiting. Therefore, other embodiments of the present invention are possible without departing from the spirit and scope of the present invention.

LIST OF REFERENCE NUMBERS

100 Familiar torsional vibration damper
110 Hub
120 Direction of rotation
200 First pendulum flange
210 U-shaped cutout
220 Middle cutout
230 First surface
240 Second surface
270 First roller cutout
280 Second roller cutout
300 Centrifugal pendulum-type absorber
301 First centrifugal pendulum-type absorber
302 Second centrifugal pendulum-type absorber
303 Third centrifugal pendulum-type absorber
304 Fourth centrifugal pendulum-type absorber
310 Direction of pendulum motion
320 First pendulum mass
330 Second pendulum mass
340 First spacing bolt
350 Second spacing bolt
360 Third spacing bolt
370 First roller
375 Third roller cutout
380 Second roller
385 Fourth roller cutout
400 Collision point
1100 First torsional vibration damper
1200 First spacing element
1210 Pendulum distance
1220 Inner distance
1230 Friction area
1240 Centrifugal force
2100 Second torsional vibration damper
2200 Second spacing element
2210 First wing
2220 Second wing
2230 Friction area
2240 Inner distance
3100 Third torsional vibration damper
3200 Third spacing element
3230 Friction area
4100 Fourth torsional vibration damper
4200 Fourth spacing element
4210 Third wing
4220 Fourth wing
4230 Friction area
5100 Fifth torsional vibration damper
5200 Fifth spacing element
5210 Pendulum distance
5220 Inner distance
5230 Friction area
5300 Second pendulum flange
5310 Wider U-shaped cutout

What is claimed is:

1. A torsional vibration damper for a drivetrain of a motor vehicle, comprising:

a discoidal pendulum flange; and,

a plurality of centrifugal pendulum-type absorbers, wherein each centrifugal pendulum-type absorber comprises:

a first pendulum mass; and,

a second pendulum mass, wherein the first pendulum mass is arranged on a first surface of the pendulum flange, the second pendulum mass is arranged on a second surface of the pendulum flange, and the first pendulum mass and the second pendulum mass are connected to each other by means of at least two respective spacing bolts, wherein the pendulum flange has a plurality of cutouts in which the at least two respective spacing bolts for said each centrifugal pendulum-type absorber are guided, wherein a first respective spacing bolt of the at least two respective spacing bolts of a first centrifugal pendulum-type absorber of the plurality of centrifugal pendulum-type absorbers and a second respective spacing bolt of the at least two respective spacing bolts of a second centrifugal pendulum-type absorber of the plurality of centrifugal pendulum-type absorbers are guided in at least one first cutout of the plurality of cutouts, wherein a spacing element is arranged in the first cutout, and the spacing element is dimensioned so that the first centrifugal pendulum-type absorber and the second pendulum-type absorber cannot contact each other, wherein the first cutout has the shape of a crescent, and wherein the spacing element has a first wing that is arranged between the first respective spacing bolt of the first centrifugal pendulum-type absorber and an edge of the first cutout, and the spacing element has a second wing that is arranged between the second respective spacing bolt of the second centrifugal pendulum-type absorber and the edge of the first cutout.

2. The torsional vibration damper as recited in claim **1**, wherein the spacing element is arranged floating in the first cutout.

3. The torsional vibration damper as recited in claim **1**, wherein the spacing element is flat and has substantially the same thickness as the pendulum flange.

4. The torsional vibration damper as recited in claim **1**, wherein the spacing element does not completely fill the space between the first respective spacing bolt of the first centrifugal pendulum-type absorber and the second respective spacing bolt of the second centrifugal pendulum-type absorber when the first centrifugal pendulum-type absorber and the second centrifugal pendulum-type absorber are in a resting position.

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